CLAIMS

1. A system comprising:

a first layer of fabric including therein at least one fiber of a first type having a tensile breaking strength of at least about 10g/Denier; and

a second layer, at least partially coextensive with the first layer comprising a microporous membrane.

2. The system as in claim 1, wherein the fiber of the first type has a tensile breaking strength of at least about 15 g/Denier.

3. The system as in claim 2, wherein the fiber of the first type has a tensile breaking strength of at least about 20 g/Denier.

4. The system as in claim 3, wherein the fiber of the first type has a tensile breaking strength of at least about 25 g/Denier.

5. The system as in claim 4, wherein the fiber of the first type has a tensile breaking strength of at least about 30 g/Denier.

6. The system as in claim 1, wherein the fiber of the first type is formed of a material selected from the group consisting of: para-aramids; liquid crystal polyesters; ultra-high molecular weight polyethylenes; and poly(p-phenylene-2,6-benzobisoxazole) (PBO).

7. The system as in claim 1, wherein the first layer consists essentially of fibers having a tensile breaking strength of at least about 10 g/Denier.

8. The system as in claim 1, wherein the first layer comprises a woven fabric having a fill yarn cover factor of at least about 75% and a warp yarn cover factor of at least about 100%.

9. The system as in claim 8, further comprising:
a third layer at least partially coextensive with the first and second layers.

10. The system as in claim 9, wherein the third layer comprises a woven fabric formed of a plurality of fill yarns and a plurality of warp yarns, with a fill yarn cover factor of less than about 75% and a warp yarn cover factor of less than about 100%.

11. The system as in claim 10, wherein the third layer includes therein at least one fiber of a second type having a tensile breaking strength of less than about 10g/Denier.

12. The system as in claim 11, wherein the fiber of the second type is formed of a material selected from the group consisting of: polyamides; cellulosic materials; polyesters; acrylic polymers; and polyolefins.

13. The system as in claim 11, wherein the third layer includes therein at least one yarn having a weight per unit length of between about 20 Denier and about 70 Denier.

14. The system as in claim 11, wherein the first layer comprises a woven fabric comprising a plurality of fill yarns and a plurality of warp yarns, wherein the fill yarns have a weight per unit length of a first value and the warp yarns have a weight per unit length of a second value that is greater than the first value.

15. The system as in claim 9, wherein the second layer is disposed between the first layer and the third layer.

16. The system as in claim 15, wherein the second layer comprises an adhesive coating attached to at least one of the first and third layer.

17. The system as in claim 16, wherein the second layer is attached to both the first layer and the third layer, thereby securing the first layer to the third layer.

18. The system as in claim 16, wherein the adhesive coating is formed of a material selected from the group consisting of: urethane adhesives and acrylic latex adhesives.

19. The system as in claim 9, wherein the first layer comprises a felted fabric.

20. The system as in claim 19, wherein the second layer is disposed between the first layer and the third layer.

21. The system as in claim 9, wherein the first layer is disposed between the second layer and the third layer.

22. The system as in claim 21, further comprising:

a fourth layer at least partially coextensive with the first, second, and third layers and disposed directly adjacent to the second layer.

23. The system as in claim 1, wherein the second layer comprises a coating adhered to at least a portion of a surface of the first layer.

24. The system as in claim 23, wherein the coating comprises a polymeric material having a modulus of elasticity of less than about 100,000 psi.

25. The system as in claim 24, wherein the coating comprises a polymeric material having a modulus of elasticity of less than about 50,000 psi.

26. The system as in claim 25, wherein the coating comprises a polymeric material having a modulus of elasticity of less than about 25,000 psi.

27. The system as in claim 26, wherein the coating comprises a polymeric material having a modulus of elasticity of less than about 10,000 psi.

28. The system as in claim 27, wherein the coating comprises a polymeric material having a modulus of elasticity of less than about 5,000 psi.

29. The system as in claim 23, wherein the coating comprises a conformal coating on the surface.

30. The system as in claim 23, wherein the coating is permeable to water vapor but is substantially impermeable to liquid water.

31. The system as in claim 23, wherein the coating comprises a hydrophobic polymeric material.

32. The system as in claim 1, wherein the second layer comprises a separable layer that is not attached to the first layer.

33. The system as in claim 1, wherein the second layer is attached to the first layer.

34. The system as in claim 33, wherein the second layer is attached to the first layer by an adhesive.

35. The system as in claim 34, wherein the adhesive comprises a material selected from the group consisting of: polyurethanes; acrylic polymers; and poly(vinyl chloride).

36. The system as in claim 33, wherein the second layer is attached to the first layer by thermal bonding.

37. The system as in claim 1, wherein the second layer comprises a hydrophobic membrane.

38. The system as in claim 37, wherein the hydrophobic membrane is formed from a material selected from the group consisting of: poly(tetrafluoroethylene); polyolefins; polyurethanes; and foamed neoprene rubber.

39. The system as in claim 37, wherein the membrane is permeable to water vapor but is substantially impermeable to liquid water.

40. An article of apparel formed, at least in part, from the system as recited in claim 1.

41. The article of apparel as in claim 40, wherein the article of apparel is selected from the group consisting of: gloves; aprons; chaps; pants; boots; gators; shirts; jackets; coats; socks; shoes; undergarments; vests; waders; hats; and gauntlets.

42. The article of apparel as in claim 41, wherein the first layer is configured and positioned to form an outer surface of the article of apparel.

43. An article of apparel formed, at least in part, from the system as recited in claim 9.

44. The article of apparel as in claim 43, wherein the article of apparel is selected from the group consisting of: gloves; aprons; chaps; pants; boots; gators; shirts; jackets; coats; socks; shoes; undergarments; vests; waders; hats; and gauntlets.

45. The article of apparel as in claim 44, wherein the first layer is configured and positioned to form an outer surface of the article of apparel.

46. An article of apparel formed, at least in part, from the system as recited in claim 22.

47. The article of apparel as in claim 46, wherein the article of apparel is selected from the group consisting of: gloves; aprons; chaps; pants; boots; gators; shirts; jackets; coats; socks; shoes; undergarments; vests; waders; hats; and gauntlets.

48. The article of apparel as in claim 47, wherein the third layer is configured and positioned to form an outer surface of the article of apparel and the fourth layer is configured and positioned to form an inner liner surface of the article of apparel.

49. A method comprising the step of:

combining a first layer of fabric including therein at least one high tenacity fibers having a tensile breaking strength of at least about 10g/Denier with a second layer comprising a microporous membrane, such that the second layer is at least partially coextensive with the first layer.

50. The method as in claim 49, wherein the combining step comprises coating the first layer with a liquid and allowing the liquid to harden to form the second layer.

51. The method as in claim 50, wherein the liquid is conformally coated onto the first layer.

52. The method as in claim 50, wherein the liquid hardens to form the second layer by solvent evaporation.

53. The method as in claim 52, wherein a rate of solvent evaporation is controlled so as to form a plurality of micropores in the second layer.

54. The method as in claim 53, wherein the second layer is rendered permeable to water vapor but substantially impermeable to liquid water.

55. The method as in claim 50, wherein the second layer is disposed on the first layer at a thickness corresponding to a specific weight of the second layer of no greater than about 1 ounce per square yard.

56. The method as in claim 55, wherein the second layer is disposed on the first layer at a thickness corresponding to a specific weight of the second layer of no greater than about 0.25 ounce per square yard.

57. The method as in claim 49, wherein the combining step comprises:

providing the microporous membrane; and

layering the membrane with first layer so that it is at least partially coextensive with the first layer.

58. The method as in claim 57, further comprising:

attaching the microporous membrane to the first layer.

59. The method as in claim 58, wherein the attaching step comprises thermal bonding.

60. The method as in claim 58, wherein the attaching step comprises applying an adhesive between the microporous membrane and the first layer.

61. A system comprising:

a first layer of a high cover factor woven fabric formed of a plurality of fill yarns and a plurality of warp yarns and having a fill yarn cover factor of at least about 75% and a warp yarn cover factor of at least about 100%; and

a second layer of a fabric, at least partially coextensive with the first layer, comprising a woven fabric formed of a plurality of fill yarns and a plurality of warp yarns and having a fill yarn cover factor of less than about 75% and a warp yarn cover factor of less than about 100%, where the system is flexible and drapable.

62. The system as in claim 61, wherein the first layer includes at least one fiber of a first type having a tensile breaking strength of at least about 10 g/Denier.

63. The system as in claim 62, wherein the fiber of the first type has a tensile breaking strength of at least about 15 g/Denier.

64. The system as in claim 63, wherein the fiber of the first type has a tensile breaking strength of at least about 20 g/Denier.

65. The system as in claim 64, wherein the fiber of the first type has a tensile breaking strength of at least about 25 g/Denier.

66. The system as in claim 65, wherein the fiber of the first type has a tensile breaking strength of at least about 30 g/Denier.

67. The system as in claim 62, wherein the fiber of the first type is formed of a material selected from the group consisting of: para-aramids; liquid crystal polyesters; ultra-high molecular weight polyethylenes; and poly(p-phenylene-2,6-benzobisoxazole) (PBO).

68. The system as in claim 62, wherein the first layer consists essentially of fibers having a tensile breaking strength of at least about 10 g/Denier.

69. The system as in claim 61, wherein at least one yarn forming the fabric of the first layer comprises a plurality of fibers including a fiber of a first type having a tensile breaking strength of at least about 10 g/Denier and a fiber of a second type having a tensile breaking strength of less than about 10 g/Denier.

70. The system as in claim 69, wherein the yarn comprises a plied yarn formed from at least a first fiber bundle and a second fiber bundle plied together and wherein the first fiber bundle comprises the fiber of the first type and the second fiber bundle comprises the fiber of the second type.

71. The system as in claim 70, wherein the first fiber bundle consists essentially of fibers having a tensile breaking strength of at least about 10 g/Denier and the second fiber bundle consists essentially of fibers having a tensile breaking strength of less than about 10 g/Denier.

72. The system as in claim 70, wherein the plied yarn is characterized by a secondary ply twist of at least about ¼ that of a primary twist of the first fiber bundle and the second fiber bundle.

73. The system as in claim 69, wherein the yarn comprises a fiber bundle including the fiber of the first type and the fiber of the second type.

74. The system as in claim 73, wherein the fiber bundle comprises a plurality of spun staple fibers.

75. The system as in claim 74, wherein the fiber bundle has a primary twist multiplier of at least about 2.7.

76. The system as in claim 74, wherein the any given cross-section of the fiber bundle along its length includes therein between about 60 and about 100 fibers.

77. The system as in claim 61, wherein in at least one of the first layer and the second layer each of the plurality of fill yarns has a weight per unit length of a first value and each of the plurality of warp yarns has a weight per unit length of a second value that exceeds the first value.

78. The system as in claim 61, wherein the fabric of the first layer has a fill yarn cover factor of at least about 80%.

79. The system as in claim 78, wherein the fabric of the first layer has a fill yarn cover factor of at least about 85%.

80. The system as in claim 79, wherein the fabric of the first layer has a fill yarn cover factor of at least about 88%.

81. The system as in claim 61, wherein the fabric of the first layer has a warp yarn cover factor of at least about 110%.

82. The system as in claim 81, wherein the fabric of the first layer has a warp yarn cover factor of at least about 120%.

83. The system as in claim 82, wherein the fabric of the first layer has a warp yarn cover factor of at least about 130%.

84. The system as in claim 83, wherein the fabric of the first layer has a warp yarn cover factor of at least about 140%.

85. The system as in claim 84, wherein the fabric of the first layer has a warp yarn cover factor of at least about 145%.

86. The system as in claim 85, wherein the fabric of the first layer has a warp yarn cover factor of at least about 150%.

87. The system as in claim 61, wherein the second layer includes at least one fiber having a tensile breaking strength of less than about 10 g/Denier.

88. The system as in claim 87, wherein the second layer includes at least one fiber having a tensile breaking strength of less than about 8 g/Denier.

89. The system as in claim 88, wherein the second layer includes at least one fiber having a tensile breaking strength of less than about 5 g/Denier.

90. The system as in claim 89, wherein the second layer includes at least one fiber having a tensile breaking strength of less than about 3 g/Denier.

91. The system as in claim 87, wherein the fiber is formed of a material selected from the group consisting of: polyamides; cellulosic materials; polyesters; acrylic polymers; and polyolefins.

92. The system as in claim 61, wherein the fabric of the second layer has a fill yarn cover factor less than about 70%.

93. The system as in claim 92, wherein the fabric of the second layer has a fill yarn cover factor less than about 60%.

94. The system as in claim 93, wherein the fabric of the second layer has a fill yarn cover factor less than about 55%.

95. The system as in claim 94, wherein the fabric of the second layer has a fill yarn cover factor less than about 50%.

96. The system as in claim 61, wherein the fabric of the second layer has a warp yarn cover factor less than about 90%.

97. The system as in claim 96, wherein the fabric of the second layer has a warp yarn cover factor less than about 85%.

98. The system as in claim 97, wherein the fabric of the second layer has a warp yarn cover factor less than about 80%.

99. The system as in claim 98, wherein the fabric of the second layer has a fill yarn cover factor less than about 75%.

100. The system as in claim 61, wherein each of the plurality of yarns forming the second layer of fabric has a weight per unit length of between about 20 Denier and about 70 Denier.

101. The system as in claim 61, wherein the first layer is not attached to the second layer.

102. The system as in claim 61, wherein the first layer is attached to the second layer.

103. The system as in claim 102, wherein the first layer is attached to the second layer by an adhesive.

104. The system as in claim 102, wherein the first layer is attached to the second layer by a double-beam partial interweave of the first and second layers.

105. The system as in claim 102, wherein the first layer is attached to the second layer by needle entangling.

106. The system as in claim 102, wherein the first layer is attached to the second layer by hydro-entangling.

107. The system as in claim 61, further comprising:
a third layer that is at least partially coextensive with the first and second layers.

108. The system as in claim 107, wherein the first layer is disposed between the second layer and the third layer.

109. The system as in claim 107, wherein third layer comprises fibers having a tensile breaking strength of less than about 10 g/Denier.

110. The system as in claim 107, wherein third layer is a fabric.

111. The system as in claim 110, wherein third layer is a woven fabric.

112. The system as in claim 110, wherein third layer is a non-woven fabric.

113. The system as in claim 110, wherein third layer comprises a random fabric web needled into and through the first and second layers.

114. The system as in claim 113, wherein third layer comprises fibers having a tensile breaking strength of at least about 10 g/Denier.

115. The system as in claim 113, wherein third layer comprises fibers having a tensile breaking strength of less than about 10 g/Denier.

116. The system as in claim 107, further comprising:

a fourth layer that is at least partially coextensive with the first, second, and third layers.

117. The system as in claim 116, wherein the first layer forms an intermediate layer.

118. The system as in claim 61, wherein the abrasion resistance of the second layer is greater than the abrasion resistance of the first layer.

119. An article of apparel formed, at least in part, from the system as recited in claim 61.

120. The article of apparel as in claim 119, wherein the article of apparel is selected from the group consisting of: gloves; aprons; chaps; pants; boots; gators; shirts; jackets; coats; socks; shoes; undergarments; vests; waders; hats; and gauntlets.

121. A system comprising:

a first layer of a felted fabric including therein at least one fiber of a first type having a tensile breaking strength of at least about 10g/Denier; and

a second layer of a fabric at least partially coextensive with the first layer.

122. The system as in claim 121, wherein the fiber of the first type has a tensile breaking strength of at least about 15 g/Denier.

123. The article as in claim 122, wherein the fiber of the first type has a tensile breaking strength of at least about 20 g/Denier.

124. The article as in claim 123, wherein the fiber of the first type has a tensile breaking strength of at least about 25 g/Denier.

125. The article as in claim 124, wherein the fiber of the first type has a tensile breaking strength of at least about 30 g/Denier.

126. The article as in claim 121, wherein the fiber of the first type is formed of a material selected from the group consisting of: para-aramids; liquid crystal polyesters; ultra-high molecular weight polyethylenes; and poly(p-phenylene-2,6-benzobisoxazole) (PBO).

127. The system as in claim 121, wherein the felted fabric consists essentially of fibers of having a tensile breaking strength of at least about 10g/Denier.

128. The system as in claim 121, wherein the felted fabric has a weight, not including and coatings or other materials applied thereto, of between about 3 ounces per square yard and about 10 ounces per square yard.

129. The system as in claim 121, wherein the felted fabric has a bulk density, not including and coatings or other materials applied thereto, of at least about 0.3 g/cm^3.

130. The system as in claim 129, wherein the felted fabric has a bulk density, not including and coatings or other materials applied thereto, of at least about 0.4 g/cm^3.

131. The system as in claim 130, wherein the felted fabric has a bulk density, not including and coatings or other materials applied thereto, of at least about 0.5 g/cm^3.

132. The system as in claim 121, wherein the thickness of the felted fabric is between about 0.012 inch and about 0.2 inch.

133. The system as in claim 132, wherein the thickness of the felted fabric is between about 0.015 inch and about 0.1 inch.

134. The system as in claim 133, wherein the thickness of the felted fabric is between about 0.015 inch and about 0.05 inch.

135. The system as in claim 121, wherein the second layer of fabric consists essentially of fibers having a tensile breaking strength of less than about 10 g/Denier.

136. The system as in claim 135, wherein the second layer of fabric consists essentially of fibers formed of a material selected from the group consisting of: polyamides; cellulosic materials; polyesters; acrylic polymers; and polyolefins.

137. The system as in claim 135, wherein the second layer of fabric comprises a woven fabric formed of a plurality of fill yarns and a plurality of warp yarns and having a fill cover factor of less than about 75% and a warp yarn cover factor of less than about 100%.

138. The system as in claim 137, wherein each of the plurality of yarns forming the second layer of fabric has a weight per unit length of between about 20 Denier and about 70 Denier.

139. The system as in claim 135, wherein the second layer of fabric is attached to the first layer.

140. The system as in claim 135, further comprising a third layer of fabric that is at least partially coextensive with the first and second layers.

141. The system as in claim 140, wherein the first layer is disposed between the second layer and the third layer.

142. The system as in claim 141, wherein the first layer is attached to both the second and the third layers.

143. The system as in claim 140, wherein the third layer of fabric consists essentially of fibers having a tensile breaking strength of less than about 10 g/Denier.

144. The system as in claim 143, the third layer of fabric comprises a woven fabric formed of a plurality of fill yarns and a plurality of warp yarns and having a fill cover factor of less than about 75% and a combined warp yarn cover factor of less than about 100%

145. The system as in claim 144, wherein each of the plurality of yarns forming the second layer of fabric has a weight per unit length of between about 20 Denier and about 70 Denier.

146. An article of apparel formed, at least in part, from the system as recited in claim 121.

147. The article of apparel as in claim 146, wherein the article of apparel is selected from the group consisting of: gloves; aprons; chaps; pants; boots; gators; shirts; jackets; coats; socks; shoes; undergarments; vests; waders; hats; and gauntlets.

148. A method comprising the step of:

combining a first layer of a felted fabric including therein at least one fiber of a first type having a tensile breaking strength of at least about 10g/Denier with a second layer of a fabric so that the second layer is at least partially coextensive with the first layer.

149. The method as in claim 148, wherein the combining step comprises layering without attaching the first layer to the second layer.

150. The method as in claim 148, wherein the combining step comprises layering and attaching the first layer to the second layer.

151. The method as in claim 150, wherein the first layer is attached to the second layer by needling.

152. The method as in claim 150, wherein the first layer is attached to the second layer by an adhesive.

153. The method as in claim 152, wherein the first layer is attached to the second layer by disposing an essentially continuous layer of an adhesive between the first and second layers.

154. The method as in claim 148, further comprising the step of:

forming the felted fabric.

155. The method as in claim 154, further comprising consolidating the felted fabric to increase its density.

156. The method as in claim 155, wherein the felted fabric is consolidated by bonding fibers within the felted fabric together with a sizing agent.

157. The method as in claim 155, wherein the felted fabric is consolidated by entangling the fibers within the felted fabric by a needling process.

158. A system comprising:

a first layer of a fabric consisting essentially of fibers of having a tensile breaking strength less than about 10g/Denier, the fibers being formed of a material selected from the group consisting of: nylon; cotton; polyester; acrylic polymers; and polyolefins; and mixtures thereof; and

a second layer of a fabric, at least partially coextensive with the first layer, including therein at least one fiber of having a tensile breaking strength of at least about 10g/Denier.

159. The system as in claim 158, wherein the fibers of the first layer have a tensile breaking strength of less than about 8 g/Denier.

160. The system as in claim 159, wherein the fibers of the first layer have a tensile breaking strength of less than about 5 g/Denier.

161. The system as in claim 160, wherein the fibers of the first layer have a tensile breaking strength of less than about 3 g/Denier.

162. The system as in claim 158, wherein the second layer consists essentially of fibers having a tensile breaking strength of at least about 10g/Denier.

163. The system as in claim 158, wherein the second layer comprises a woven fabric formed of a plurality of fill yarns and a plurality of warp yarns.

164. The system as in claim 163, wherein the woven fabric comprising the second layer has a fill yarn cover factor of at least about 75% and a warp yarn cover factor of at least about 100%.

165. The system as in claim 163, wherein the first layer and the second layer are attached to each other.

166. The system as in claim 163, further comprising:
a third layer that is at least partially coextensive with the first and second layers.

167. The system as in claim 166, wherein the second layer is disposed between the first layer and the third layer.

168. The system as in claim 166, wherein the third layer comprises a fabric.

169. The system as in claim 168, wherein the third layer consists essentially of fibers of having a tensile breaking strength less than about 10g/Denier.

170. The system as in claim 168, wherein the third layer comprises a woven fabric.

171. The system as in claim 166, wherein the second layer is attached to both the first layer and the third layer.

172. An article of apparel formed, at least in part, from the system as recited in claim 158.

173. The article of apparel as in claim 172, wherein the article of apparel is selected from the group consisting of: gloves; aprons; chaps; pants; boots; gators; shirts; jackets; coats; socks; shoes; undergarments; vests; waders; hats; and gauntlets.

174. A system comprising:

a first layer of a woven fabric formed of a plurality of fill yarns, having a weight per unit length of a first value, and a plurality of warp yarns, having a weight per unit length of a second value greater than the first value; and

a second layer that is at least partially coextensive with the first layer.

175. The system as in claim 174, wherein the first layer includes therein at least one fiber of a first type having a tensile breaking strength of at least about 10g/Denier.

176. The system as in claim 175, wherein the fiber of the first type is formed of a material selected from the group consisting of: para-aramids; liquid crystal polyesters; ultra-high molecular weight polyethylenes; and poly(p-phenylene-2,6-benzobisoxazole) (PBO).

177. The system as in claim 175, wherein the first layer consists essentially of fibers having a tensile breaking strength of at least about 10g/Denier.

178. The system as in claim 175, wherein the woven fabric comprising the first layer has a fill yarn cover factor of at least about 75% and a warp yarn cover factor of at least about 100%.

179. The system as in claim 174, wherein the second layer comprises a fabric.

180. The system as in claim 179, wherein the second layer comprises a woven fabric formed of a plurality of fill yarns and a plurality of warp yarns.

181. The system as in claim 180, wherein the second layer consists essentially of fibers having a tensile breaking strength of less than about 10g/Denier.

182. The system as in claim 180, wherein the woven fabric comprising the second layer has a fill yarn cover factor of less than about 75% and a warp yarn cover factor of less than about 100%.

183. The system as in claim 182, wherein each of the plurality of yarns forming the second layer of fabric has a weight per unit length of between about 20 Denier and about 70 Denier.

184. The system as in claim 179, wherein the first layer and second layer are attached to each other.

185. The system as in claim 174, further comprising:
a third layer that is at least partially coextensive with the first and second layers.

186. The system as in claim 185, wherein the first layer is disposed between the second layer and the third layer.

187. The system as in claim 186, wherein the first layer is attached to both the first and third layers.

188. The system as in claim 186, wherein the third layer comprises a woven fabric formed of a plurality of fill yarns and a plurality of warp yarns.

189. The system as in claim 188, wherein the third layer consists essentially of fibers having a tensile breaking strength of less than about 10g/Denier.

190. The system as in claim 188, wherein the woven fabric comprising the third layer has a fill yarn cover factor of less than about 75% and a warp yarn cover factor of less than about 100%.

191. An article of apparel formed, at least in part, from the system as recited in claim 174.

192. The article of apparel as in claim 191, wherein the article of apparel is selected from the group consisting of: gloves; aprons; chaps; pants; boots; gators; shirts; jackets; coats; socks; shoes; undergarments; vests; waders; hats; and gauntlets.